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Program Affordability Tradeoffs

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Panel 22. Improving Project Management of Complex Systems

Thursday, May 5, 2016	
3:30 p.m. – 5:00 p.m.	**Chair: William Taylor, Col, USMC (Ret.),** Program Executive Officer Land Systems, Marine Corps ***A Conceptual Framework for Adaptive Project Management in the Department of Defense*** Martin Brown, Jr., Project Manager, Program Executive Office for Enterprise Information Systems ***Program Affordability Tradeoffs*** Brian Schmidt, Economic Analyst, The MITRE Corporation Josie Sterling, Economic/Business Analyst, The MITRE Corporation Patricia Salamone, Business and Investment Analyst, The MITRE Corporation Ginny Wydler, Principal Analyst, The MITRE Corporation ***Squaring the Project Management Circle: Updating the Cost, Schedule, and Performance Methodology*** Charles Pickar, Senior Lecturer, NPS

Program Affordability Tradeoffs

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Josie Sterling—has been an Economic/Business Analyst at the MITRE Corporation since 1982, supporting cost analysis, analysis of alternatives, economic analysis, cost/benefit analysis, affordability engineering, trade-studies, and risk assessment and management for a variety of civilian and DoD sponsors. She holds a master's degree in mathematics from Tufts University. [sterling@mitre.org]

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Abstract

In today's fiscal environment, federal programs must be postured to conduct on-going tradeoff analyses to stay affordable as budgets are reduced and capabilities change or become more challenging to implement. This research focuses on recommended practices for conducting economic resource-constrained tradeoff analyses. The goal is to offer guidance to programs in making cost-effective affordability decisions that keep the program within its budget, or to find economic efficiencies if the program is currently affordable and within its budget.

Background

Over the years, there have been major efforts within the federal government to reduce the cost of acquiring systems. The Government Accountability Office has shown repeated problems in meeting program milestones and keeping programs within cost and schedule requirements. Since 2010, the Department of Defense (DoD) has issued three versions of Better Buying Power for the DoD acquisition community, emphasizing the need for "affordability" (Carter, 2010; Kendall, 2012, 2015).

In response to these problems, the MITRE Corporation conducted an internal research project resulting in the Affordability Engineering Framework (AEF). The AEF, shown at a high-level in Figure 1, provides a structured framework with approaches and tools to address program affordability challenges over the life cycle (MITRE Corporation, 2012).

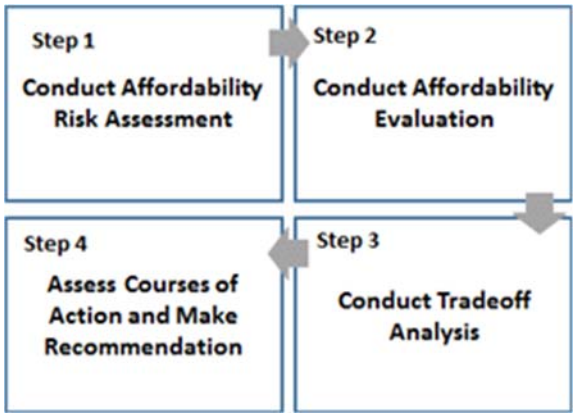

Figure 1. AEF Framework

Step 1 of the AEF is to identify and assess potential risks to program affordability, and to initiate actions to mitigate those risks. Step 2 is to examine the sufficiency of the program baseline and corresponding cost and schedule estimates, then to compare this cost estimate with the budget profile to evaluate life cycle affordability. Step 3 is to conduct a tradeoff analysis of courses of action for the purpose of making the program affordable or, if the program is currently affordable, to explore opportunities to improve program efficiencies. Finally, the objective of Step 4 is to help the decision-maker select the appropriate course(s) of action.

The research described in this summary is intended to facilitate Step 3 of the AEF. Specifically, the purpose of our research is to (part 1) gain an understanding of how government program offices currently conduct tradeoff analyses and (part 2) develop a guidance document and a software tool to help them with this process. This summary describes shortfalls in current practice that came to our attention during part 1 and recommendations for correcting these shortfalls. These recommendations will influence part 2, which is now under way.

Approach and Findings

To better understand how program offices deal with affordability challenges and tradeoff analyses, we conducted interviews with MITRE staff supporting 19 government sponsors. The main topics of the interviews were to understand the following: what affordability tradeoff analyses programs typically conduct and what decisions are supported by the results of the analyses; what factors (inputs) are considered in conducting tradeoff analyses and how are they considered; and what resources (people, tools, time) are available to conduct these analyses. The information we gained from conducting these interviews will assist us in part 2 of our research (developing a guidance document and tool). Meanwhile, this summary paper deals with shortfalls in current practice that came to our attention in the course of the interviews. These shortfalls were in three areas: measuring benefit, combining metrics, and assessing risk in tradeoff analyses.

Measuring Benefit

In many studies, the only measure of benefit was a technical performance measure, such as the speed of an aircraft. No attempt was made to connect this to a measure of effectiveness, which expresses how well the system carries out its operational mission. This approach leads to a “more is better” outlook. It does not provide insight into how much operational value is diminished when a lower cost alternative is selected and whether this is acceptable. In studies that used metrics that were not easy to express in scientific units,

such as “the ability to conduct close air support,” the system that was adopted for scoring was often not carefully constructed. For example, numerical scores were not given clear interpretations.

The authors recommend adherence to established decision analysis methods for rating value or utility. For further information on these methods, see Von Winterfeldt and Edwards’ (1986) *Decision Analysis and Behavioral Research*, Chapter 7.

Combining Metrics

In studies that combined the scores of several metrics, weighted averages were almost always used. Although the weighted average is known to be the correct function to use when certain independence conditions hold (see, for example, Kirkwood, 1997, p. 243), there are cases in which such conditions do not hold, as is illustrated by a classic study of the Mexico City airport (Keeney & Raiffa, 1993, Chapter 8). The inappropriate choice of a function can lead to misleading assessments of overall benefit. For example, an alternative that improves the overall benefit score may be one that is improving metrics that are already at an acceptable level, while leaving other metrics below acceptable levels.

To ensure that tradeoffs are represented realistically, the authors recommend that analysts be aware of the existence of functions other than averages that can be used to combine metrics. Some examples are the Multiplicative Utility Function (Keeney & Raiffa, 1993), the exponential average (Schmidt, 2015), and the max-average (Lamar, 2009). We are continuing research to investigate methods for making these concepts more understandable and useable for program tradeoffs.

Assessing Risk in Tradeoff Analyses

Risk was often not considered, or was considered improperly, in affordability tradeoff analyses. For example, in some studies risk was assessed for one candidate system but not for another. In other studies, only one type of risk (e.g., schedule risk) was considered, while other types (e.g., cost, technical maturity, interoperability, and statutory/regulatory) were ignored.

Our recommendation is to consider what we call the execution risk framework (Henry, 2011). This method evaluates each alternative across a number of risk sources or categories. For each alternative, the risk for each category is assessed using a utility-like scale. Once an assessment is made for each category, these scores can be combined using a variety of methods, including the max-average (Lamar, 2009) or exponential average (Schmidt, 2015). Risk scores can then be used to calculate risk-adjusted benefit. In addition, understanding where there is risk for a given alternative guides the formulation of new risk-reduction alternatives, which include risk mitigation activities and costs for those activities.

Next Steps

The next step in this research (part 2) will be to construct a guidebook on recommended practices and a software tool to help program offices make analytically-driven tradeoff decisions. This research will result in a simple-to-use tool enabling programs to conduct affordability tradeoff analyses on a regular basis. Although this study focused on DoD program offices, our intent is that all federal agencies will gain from the findings of this research and the products that will become available.

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Program Affordability Tradeoffs

Naval Postgraduate School 13th Annual Acquisition Research Symposium

5 May 2016

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Ms. Ginny Wydler

Introduction

- **In today's fiscal environment, federal programs must be postured to conduct on-going tradeoff analyses to stay affordable**
  - As budgets are reduced, need to re-scope wisely
  - As capabilities change or become more challenging to implement, need to stay within the budget in the life-cycle
- **Our research focuses on recommended practices for conducting economic resource-constrained tradeoffs**
  - Part 1 was designed to understand how government offices currently conduct these affordability tradeoffs, where there is need for improvement
  - Part 2 will be to develop guidance for recommended approaches and develop a software tool to help programs implement these recommended approaches
- **This paper describes our findings for Part 1**

Want versus Need – Fuel Efficiency*

Tesla Model S accelerates from 0 to 60 mph in as little as 2.8 seconds.

Prius Model 2 fuel economy (MPG): 54 - 58 city | 50 - 53 highway

Trade-Off Analysis

Costs:	$80,000	$22,000
Risks:	Speed	Few
Benefits:	Neighbor envy	MPG bragging rights

*Sources: Wikipedia and auto manufacturer websites

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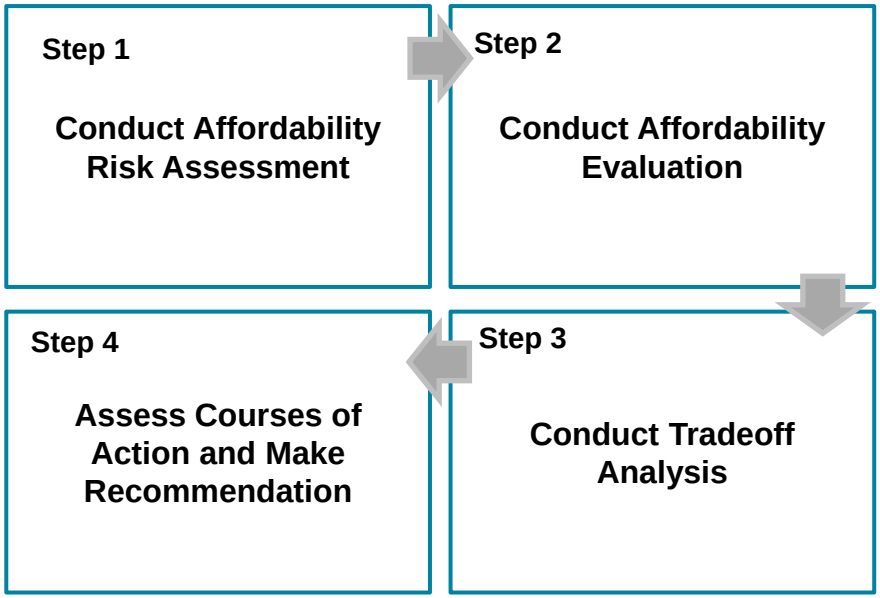
Background

- Over the years there have been major efforts within the federal government to reduce the cost of acquiring systems
- The Government Accounting Office (GAO) has shown repeated problems in meeting program milestones and keeping programs within cost and schedule requirements
- Since 2010, the Department of Defense (DoD) has issued three versions of “Better Buying Power” for the DoD acquisition community, emphasizing the need for “affordability.” [1], [4], [5] (See slide 12 for references)
- In response to these challenges, The MITRE Corporation developed the Affordability Engineering Framework (AEF) [9], which provides a structured framework with approaches and tools to address program affordability challenges over the life-cycle

The Affordability Engineering Framework (AEF)

- **The MITRE-developed AEF framework [9] is a continuous process that consists of four steps:**
  - Step 1 guides programs through a self-assessment of risks to affordability based on where they are in the life-cycle
  - Step 2 is a comparison of the Program Office Estimate (POE) with the budget
  - Step 3 provides guidance for conducting tradeoffs to ensure affordability and/or improve efficiencies and effectiveness
  - Step 4 is the selection of the best course of action and summarizing for decision-makers



The research in this paper is intended to facilitate Step 3 of the AEF

Part 1 Approach: Program Interviews

- **Part 1 of this research consisted of 19 interviews with government sponsors**
- **Main topics of the interviews were:**
  - What affordability tradeoff analyses are typically conducted and what decisions are supported by the analyses
  - What factors (inputs) are considered and how
  - What resources (time, people, tools) are available to conduct these analyses
- **The information gained from these interviews will help in the development of the guidance document and tool**
- **Of the findings, three were prevalent:**
  - Poor practice in choosing benefits metrics and measuring benefits
  - Combining metrics limited to linear methods
  - Risk not considered or considered incorrectly

Finding 1: Benefits Metrics and Measurement

- **Problem: Often the measure of benefit was technical performance (e.g., the speed of an aircraft) and the measures were not linked to extent of achieving goals/mission/objectives**
  - Leads to a “more is better” outlook
  - Does not allow for exploring affordability trades
    - What is the impact to goals/missions/objectives of pursuing a lower cost, lower performing alternative? Is this impact acceptable?
- **Problem: Numerical scores for benefit were not given clear interpretations**
- **Solution: Ensure that technical measures are linked to mission-level metrics, and adhere to established decision analysis methods for rating value or utility [11, Chapter 7]**

Finding 2: Combining Benefits Metrics

- **In studies that combined the scores of several metrics, weighted averages were almost always used**
- **Although the weighted average is the correct function to use when certain independence conditions hold, there are cases where these conditions do not hold [7], [3]**
  - E.g., a classic study of Mexico City Airport found that weighted average was not appropriate [3, Chapter 8]
- **The inappropriate choice of a function can lead to misleading assessments of overall benefit**
  - E.g., an alternative that improves the overall benefit score may be one that is improving metrics already at an acceptable level, while leaving other metrics below acceptable levels
- **Solution: Analysts should be aware that the weighted average is not always appropriate and be aware of alternative functions for combining benefits metrics**
  - E.g., exponential average and max-average [8], [10]

Finding 3: Alternative Risk Assessments

- **Problem: The risk of achieving the measured benefits for the estimated costs is not often considered, or considered improperly**
  - Must consider risk from all sources (e.g., technical maturity, interoperability, statutory/regulatory), not just the standard sources of cost, performance and schedule
- **Solution: Consider what we refer to as the "execution risk framework" [2]**
  - Evaluate risk for each alternative across a number of risk sources using a utility-like scale
  - Scores can be combined using methods discussed under Finding 2
  - Understanding the risk of an alternative can lead to new alternatives which contain mitigation efforts and the cost of those mitigations

Summary and Next Steps

- **Part 1 of our research efforts found a few key areas where improvement is needed as program offices are challenged to understand how to keep programs affordable**
- **The next step (part 2) will be to construct a guidebook on recommended practices, leveraging work done for the MITRE AEF, and development of a software tool to help programs make analytically-driven tradeoff decisions on a regular basis**
- **The intent is that all federal agencies, DoD and civilian, will gain from findings on this research and the products that will become available**

Want versus We Think We Need – Stealth*

Lockheed Martin F-35 Lightning II

F-35A Cost: $85M, full production in FY2018

Sometimes you just need a nice ride

The F-117 Nighthawk stealth attack aircraft

The B-2 Spirit strategic stealth bomber

The F-22 Raptor fifth generation stealth air superiority fighter

F-22 $150M/Unit
F-117 $111M/Unit
B-2 $737M/Unit

*Sources: Wikipedia

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